REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in view of the following discussion is respectfully submitted.

Claims 1, 4-8, and 11-22 are pending in the present application with Claims 15-20 withdrawn from consideration. Claims 1 and 8 are amended, Claims 2, 3, 9, and 10 are cancelled without prejudice, and Claims 21 and 22 are added by the present amendment.

In the outstanding Office Action, the title was objected to; Claims 1, 2, 5, and 7 were rejected under 35 U.S.C. § 102(b) as anticipated by Kubo (Japanese Patent Application Publication No. 2001-284588); and Claims 6, 8-10, and 12-14 were rejected under 35 U.S.C. § 102(b) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over Kubo; and Claims 4 and 11 were rejected under 35 U.S.C. § 103(a) as unpatentable over Kubo and Hshieh (U.S. Patent No. 6,262,453).

Regarding the objection to the title, the title has been amended to be more descriptive of the claimed invention without adding new matter. Accordingly, it is respectfully requested this objection be withdrawn.

In light of the outstanding rejections on the merits, Claim 1 has been amended to recite the features of Claims 2 and 3 and thus, Claims 2 and 3 have been cancelled. Further, Claim 8 has been amended to recite the features of Claims 9 and 10, and thus, Claims 9 and 10 have been cancelled. No new matter has been added.

Briefly recapitulating, amended Claim 1 is directed to a semiconductor device that includes, inter alia, a first semiconductor layer of a first conductivity type, a second semiconductor layer of a second conductivity type provided on the first semiconductor layer, a trench penetrating the second semiconductor layer and intruding into the first semiconductor layer, a thick gate insulating film provided on a inner wall of the trench below

an upper surface of the first semiconductor layer, a thin gate insulating film provided on the inner wall of the trench at a part higher than the thick gate insulating film, a gate electrode filling the trench, and a semiconductor region of a second conductivity type selectively formed to adjoin the trench and to project from a bottom surface of the second semiconductor layer into the first semiconductor layer. A lower end of a part of the semiconductor region of the second conductivity type in contact with the trench is substantially at a same level as a boundary between the thick gate insulating film and the thin gate insulating film, and a carrier concentration of the semiconductor region of the second conductivity type is higher than a carrier concentration of the first semiconductor layer and lower than a carrier concentration of the second semiconductor layer. Independent Claim 8 has been amended similar to Claim 1.

The features added to Claims 1 and 8 are disclosed in the specification at page 12, lines 6-19. More specifically, the specification states:

> The concentration of the p-type base region 5 is about 10^{17}-10^{18}/cm^3, and the concentration of the n-type epitaxial region 6 is in the order of 10^{16}/cm^3. It is desirable to make the concentration of the p-type region 9 between the concentrations of the base region 5 and the epitaxial region 6. That is, the carrier concentration of the p-type region 9 can be set to about 10^{17}/cm^3. If the carrier concentration of the p-type region 9 is set to this range, the reversal of the conduction-type of the n-type epitaxial region 6 can be caused easily by introducing the p-type impurity into it. Moreover, the carrier concentration of the p-type base region 5 will not go up too much.

None of Kubo and Hshieh teaches or suggests such unique features. Kubo forms a p-type channel layer (11) in a single implantation step as shown in Figure. 6. Therefore, in the structure of Kubo, the carrier concentration of the channel layer (11) becomes uniform along the depth direction of the trench (7) as schematically indicated by dots in the Reference Figure 1 attached to this response. It is noted that Reference Figure 1 corresponds to the right side of Figure 6 of Kubo.

To obtain a high breakdown voltage (Vdss) and low capacitance (Cds) between source and drain, it becomes necessary to make the channel layer (11) thicker in Kubo. However, in Kubo's structure, the threshold voltage increases as the channel layer becomes thicker. This is because the carrier concentration of the channel region (indicated by dots in the Reference Figure 1) increases under the dose condition. Thus, in Kubo's structure, it is difficult to control the threshold voltage while obtaining a high breakdown voltage and a low capacitance.

Hshieh does not cure the deficiencies of Kubo discussed above. It is noted that Hshieh has not been used by the outstanding Office Action against original Claims 3 and 10.

According to the claimed invention and as noted above in the specification, the p-type base region 5 and the p-type region 9 are formed separately as explained with reference to Figures 4A through 4D, for example. Namely, the p-type base region 5 is formed as shown in Figure 4A, and the p-type region 9 is formed by a slant implantation as shown in Figure 4C. By employing such multi-step process, it becomes possible to make the base region 5 thick enough while keeping the threshold in a desired range. In the amended Claims 1 and 8, the carrier concentration of the semiconductor region of the second conductivity type is lower than a carrier concentration of the second semiconductor layer. That is, the carrier concentration of the p-type region 9 is kept lower than that of the base region 5. Such a unique feature is neither suggested nor taught by Kubo or Hshieh.

The semiconductor device of Claims 1 and 8 advantageously achieves a threshold voltage that does not increase by the implantation of impurities in the p-type region 9, by employing such a relationship of the carrier concentrations as claimed. Namely, the threshold voltage is set by the carrier concentration of the base region 5 whose carrier concentration is higher than that of the p-type region 9. As a result, a high breakdown

voltage and a low capacitance (Cds) are obtained at a desired threshold voltage. At the same time, an increase of an ON resistance (Ron) is suppressed and the capacitance (Cgd) can be reduced.

Accordingly, it is respectfully submitted that independent Claims 1 and 8 and each of the claims depending therefrom patentably distinguish over the applied art.

New Claims 21 and 22 are added to set forth the invention in a varying scope and Applicants respectfully submit the new claims find support in the originally filed specification. More specifically, the features of Claims 21 and 22 are described, for example, in Figure 1. That is, a thickness (t) of the base region 5 is greater than a width (w) of the p-type region 9 at a part adjoining the base region 5 as shown in attached Reference Figure 2. Such a unique feature can be obtained by the multi-step process described above. None of the recited references suggest or teach such unique features.

Because Claims 21 and 22 depend from Claims 1 and 8, respectively, which are believed to be allowable as noted above, it is respectfully submitted that Claims 21 and 22 are also allowable.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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